

651.1303 Safety

(a) Hazards from gases

The decomposition of manure in storage or handling systems generates gases, some of which are toxic, explosive, and oxygen displacing. The most hazardous gases are hydrogen sulfide (H_2S), ammonia (NH_3), methane (CH_4), and carbon dioxide (CO_2). Dangerous levels of these gases can accumulate in and around manure management systems, particularly when manure is being agitated or otherwise disturbed.

While manure is the primary source for hazardous gases associated with waste storage systems, the decomposition of other organic materials, such as milking center waste, waste feed, feed leachate, and any combination of these materials, may pose similar risks.

(1) Gases produced in an AWMS

Carbon dioxide (CO_2) - Carbon dioxide is not itself toxic, but it will displace oxygen and can cause death by asphyxiation at high concentrations. It is heavier than air and can accumulate near the bottom of enclosed spaces. Exposure to high concentrations of carbon dioxide may result in headaches and dizziness.

Ammonia (NH_3) - Ammonia has a sharp pungent odor and is generally higher in poultry manure. It is a corrosive gas that is lighter than air. Ammonia causes irritation of the eyes and respiratory tract. At higher concentrations, this gas may cause permanent lung damage.

Hydrogen sulfide (H_2S) - Hydrogen sulfide levels may increase a thousand-fold during agitation. This extremely toxic gas is the most dangerous manure gas as it is colorless, heavier than air, and may cause death in seconds at high concentrations.

Methane (CH_4) - Methane is highly flammable. A spark from equipment, open flames, smoking materials, faulty wiring, or welding could provide an ignition source for an explosion or fire. Methane is odorless, colorless and lighter than air. It is most likely to accumulate during hot weather if ventilation is inadequate. By displacing air at high

concentrations, methane, which in itself non-toxic, can become an asphyxiant and will cause rapid breathing, dizziness, and fatigue.

(2) Gas hazard situation categories

Confined space - Sites of human entry into areas where manure gases could concentrate should be identified and addressed within a detailed plan for safe entry procedures and safety features. All sources of entry into a confined space, such as lids, gates, hatch covers and safety grills, should be secured when left unattended. Temporary access ladders should not be left leaning against above ground tanks.

Smoking, open flames, or spark-producing operations, such as welding or the use of saws, drills, or shop vacs, should be forbidden in the vicinity of the storage area to prevent a methane explosion. Electric motors, fixtures, and wiring near manure storage areas should be maintained in good condition.

Drive-in covered storage tanks and transfer channels are difficult or impossible to operate in accordance with published safety standard ASAE EP470. These structures present a potential safety hazard and should be avoided.

NRCS employees shall not enter a confined space for construction inspection or any other purpose without proper authorization. All requests for authorization to enter confined spaces shall be submitted to the state conservation engineer, as required by policy in the National Engineering Manual.

When a structure that meets the criteria for a confined space is included in a set of plans, an appropriate warning statement shall be included in the operation and maintenance plan.

(b) Hazards with impoundments

(1) Covered Storage Tanks

These systems are characterized by a vertical walled concrete structure with either a slatted or solid top, or some combination of slatted or solid top or cover. These structures are usually located beneath a barn where manure enters the structure from above through the slatted floor or slots cast into solid

portions of the tank top. Stored waste is usually removed from the tank by pumping or by gravity flow. These structures may also include a conveyance channel that extends from the barn to an exterior storage structure. The purpose of these structures is to provide short-term waste storage and/or transfer.

These structures may contain toxic concentrations of hydrogen sulfide gas even if the structure has been emptied of manure, but the risks for development of toxic gases is highest when wastes are being agitated and moved. Additionally, there is danger of asphyxiation by oxygen displacing gases as well as the risk of methane explosion. The risk of injury from falls and drowning risks may also exist.

These structures may contain toxic concentrations of hydrogen sulfide gas, particularly when wastes are being agitated and moved. Dividing pits into smaller compartments can reduce or eliminate the need for agitation. Pump-out access points should be located outside of buildings and covered with a heavy cover or grate.

Covered storage tanks under buildings should not be filled completely. Leaving 1 to 2 feet of air space provides capacity for storing gases which accumulate at the top of the tank. Lower the level of liquid manure in the storage tank before starting agitation to reduce the possibility of gas being forced above floor level. Keep the agitator below the liquid surface because gas is released in greater volumes with vigorous surface agitation. Keep people out of a building where manure is being agitated or emptied. Provide strong mechanical ventilation during agitation and pumping, and for a few hours after pumping has stopped. No one should work alone when agitating or emptying a manure facility.

Pipelines shall be provided with a water-sealed trap and vent or similar device if there is a potential, based on design configuration, for gases to enter enclosed buildings or other confined spaces.

Drive-in covered storage tanks and transfer channels

Covered storage tanks and transfer channels may also include by a ramp or opening that provides entry by a skid loader or other human-operated

equipment into the tank or channel for the purpose of removing residual solids. NRCS must never design or plan a structure intended to be operated in this manner.

Skid loaders or similar equipment cannot be operated in covered tanks or transfer channels in accordance with ASAE EP470. This standard requires that a safety harness and rope be attached to the person working in the structure with at least one person standing by with a mechanical retrieval device. It is not possible to use a mechanical retrieval device for a person who is overcome with manure gases while operating a skid loader or similar equipment in these tanks. Skid loaders and similar equipment often have enclosed cabs, making it impossible for an operator to be removed from the cab using a mechanical retrieval device.

An alternative to a drive-in covered storage tank and transfer channel system is a larger reception tank which includes a pump that is used to transfer waste material to long-term storage. The reception tank shall be designed and operated in compliance with the provisions contained in ASAE EP470, Manure Storage Safety.

Smaller, narrower transfer channels (typically 2 to 4 feet wide, 4 to 6 feet deep) with a removable top can be used to transfer manure from the covered storage tank below the building to a larger reception tank located outside of the building. The smaller transfer channel can be cleaned from above by removing the top so that human entry into the channel is not needed. Alternately, the channel could incorporate a mechanical cleaner or series of horizontal augers to move waste without the need for human entry into the channel. Non-mechanical systems can also incorporate a "chaser" of flush water to prevent waste accumulation.

(2) Open Manure Storage Pits and Tanks

These systems are characterized by an embankment structure, excavated pit, dugout or fabricated structure that is used to contain manure, milking center waste and other organic waste generated by a livestock facility prior to land application or treatment. The manure surface of an "open" storage is exposed to the elements and is not under a building, nor does it have a lid, cover, slats, or other

enclosing structures preventing open circulation and air exchange. The sides may be vertical or sloped.

The primary gas safety hazards are from hydrogen sulfide and ammonia exposure. Open manure storage is generally not as hazardous as covered storage or other manure facilities in buildings. However, during times when the manure is being agitated or when air movement is limited, gas levels may become dangerous within and near the storage.

Open manure storage pits, tank systems and stacking facilities with a potential to impound liquids shall include appropriate safety features to minimize the hazards of the facility. Ladders, ropes, bars, rails, walkout ramps and other devices shall be included, as appropriate, to help animals and humans who may fall into to a pit or tank to climb out. Ponds and uncovered fabricated structures that impound liquid or slurry waste which have walls which extend less than 5 feet above ground surface shall be fenced to prevent children and animals from entering them or using them for other than their intended purpose. Landowners should contact their insurance company to inquire about other requirements they may have for fencing. Warning signs are required for storage ponds, storage structures, confined spaces and other facilities that may present a hazard to humans.

Stacking facilities which include vertical walls which have fill extending to the top of the wall on the outside should be fenced to prevent vehicles, people or animals from dropping off of the top of the wall into the stacking facility storage area.

Ramps used to provide vehicular equipment access to the pond bottom shall have a slope of 10:1 (horizontal:vertical) or flatter unless special traction surfaces are provided. Equipment access ramps and embankment slopes shall be compatible with the equipment intended to be used. Safety stops, gates, or both must be installed at push-off ramps and load-out areas of impoundments and structures to prevent accidental entry of machinery. Piers and push-off platforms should have a barrier strong enough to stop a slow moving tractor. Guardrails should be built for any walkways on piers or walls surrounding open storage structures. A mid-rail and toe boards should be installed.

Gravity discharge pipes used for emptying a storage/treatment facility shall have a minimum of two gates or valves, one of which shall be manually operated. The rate of valve closure must be slow enough to prevent pressure surges. A minimum of one in-line manual valve shall be provided in the transfer pipe when the maximum operating level of the storage facility is higher than the top of the transfer structure.

Safety plans for these systems should include warnings to avoid agitation when air movement is limited and that entry should be minimized and only occur when natural ventilation is assured.

(3) Reception Tanks, Pump Chambers, and Manholes

These systems are characterized by vessels in which manure, milking center waste, feed storage leachate, or other organic waste is collected or stored for short periods of time before removal or transfer to storage or treatment. The vessel is usually of a size and capacity to accommodate one or more waste collection cycles, and may be emptied as frequently as several times daily or as long as weekly.

Where a sump is included in a design, flexible discharge hoses, guide rails with flange connections, or other mechanical methods shall be used to eliminate the need for sump entry during pump maintenance.

It is difficult to limit the use of these structures. However, the need for human entry can be minimized and safeguarded. Design features that preclude the need for human entry for maintenance including removable pumps and “dry” pump chambers should be considered.

A site-specific safety plan should be developed for human entry. Plans should comply with state regulations and ASAE EP470 recommended safety procedures and may include the following:

- monitoring,
- ventilation,
- rescue procedures,
- SCBA (Self Contained Breathing Apparatus), and
- lock-out/tag-out procedures.

(4) Manure Processing Rooms and Buildings

These systems are characterized by enclosed structures or portions of structures designed to provide protection from precipitation and freezing for manure processing, handling and storage equipment such as manure solids separators, sand separators, methane powered electrical generators, manure treatment equipment, manure reception and loading areas.

The primary gas safety hazards are from high levels of ammonia causing respiratory injury, from methane explosion, and from hydrogen sulfide exposure. Asphyxiation from engine exhaust from generator sets or handling machinery may also exist in buildings containing this equipment or adjacent buildings. Heat exposure and high decibel sound may also be safety hazards. Secondary hazards are associated with the corrosion of building components from hydrogen sulfide exposure, particularly electrical equipment, creating the risk of electrical shock or spark ignition of methane. These structures are usually not "confined areas" and may be intended for routine human occupancy.

Facility designs should avoid locating processing rooms in multiple-use buildings, particularly those for frequent human occupancy. Potentially hazardous activities should be located in separate, isolated buildings. If processing rooms are located in multiple-use buildings, ensure that adequate ventilation is provided in order to maintain safe conditions and a safe and practical temperature. In most cases, power ventilation will be required. Consideration should be given to equipping the building or room to ventilate at a base rate as well as a higher air exchange rate to evacuate the building or room before and during occupancy. In-place gas monitoring should be considered. Warning signs should be posted at entries.

A site-specific safety plan shall be developed that may include the following:

- warning signs stating entry procedures;
- emergency response plans;
- monitoring protocols;
- hearing protection; and
- equipment maintenance and inspection.